REMARKS

Claims 1-15 are pending.

The amendment to claims 1-3 is supported by page 12, line 3 and page 21, the third line from the bottom, of the specification as originally filed.

Lack of Unity of Invention

The Office Action stated that applicants' traversal of the lack of unity of invention holding was not found persuasive because the Examiner asserted that claim 1 was obvious in view of cited references of record. Applicants respectfully disagree that claim 1 was obvious in view of the prior art of record as discussed below. Accordingly, applicants respectfully request that claims 8-13 be rejoined with claims 1-7, 14 and 15 in the examination on the merits because the special technical features linking the examined claims and non-elected claims did provide a contribution over the prior art and a single inventive concept existed.

Claim Rejections under 35 U.S.C. §112

Applicants would like to thank Examiner Ip for holding in the Advisory Action that the amendment of March 24, 2003 has overcome all rejections of claims 1, 2, 5, 6, 14 and 15 made under 35 U.S.C. §112.

Claim Rejections under 35 U.S.C §103

Claims 1-7, 14 and 15 were rejected as obvious over JP 07214216 (hereinafter JP '216) or Izawa et al. (U.S. Patent No. 5,665,179) in view of Yamada et al. (U.S.

Patent No. 5,816,088) and further in view of JP 08053711 (hereinafter JP '711). Applicants respectfully traverse the rejections.

There are at least 3 differences between Izawa et al and the rejected claims.

First Difference. The shot used by Izawa in the second stage of the shot peening is larger than the fine metal particles, wherein the mean diameter of each particle is in the range between 10 μm and 80 μm inclusive, used in the shot peening steps, e.g. step (C) of claim 1 or step (D) of claim 2, of the claimed methods.

Second Difference. Izawa does not teach controlling the temperature rise in the second stage of the shot peening to below the temperature at which recrystallization may occur and yet be enough to cause work hardening.

Third Difference. Izawa does not specifically teach the shot velocity of the fine metal particles such as that required in step (C) of claim 1 or step (D) of claim 2 (i.e., 50 to 190 m/sec), or claim 3, i.e., 50 to 150 m/sec.

As explained below, Yamada and JP '711 fail to cure these three deficiencies of Izawa et al.

Regarding the first difference, the Office Action attempted to rely upon Yamada, which teaches shot peening of carbon steel with fine shot particles. However, Izawa et al and Yamada should not be combined because the teachings of Yamada would not have yielded a reasonable expectation of success if applied to modify the method of Izawa et al. Izawa et al teaches two-stage shot peening of **nitrided** coil spring. The steel workpiece shot peened in the method of Yamada was made of carbon steel. Yamada makes no mention of nitriding the steel workpiece. In reading Izawa et al and Yamada, a person of ordinary skill in the art would have reasonably predicted that the

fine particles used in the shot peening of the carbon steel workpiece of Yamada would not be suitable for shot peening of the nitrided coil spring of Izawa et al.

This is because the person would have known that residual stress is obtained as a result of plastic deformation. The portion of **nitrided** springs at the surface has been known to be **very hard** and not easily deformed plastically by shot peening because the very hard portion has very high yield stress. The person would have known that, in order to create plastic deformation in nitrided surface layer with high hardness, it is important to use shot particles of high kinetic energy in shot peening treatments. Since the kinetic energy of a shot particle is proportional to the cube of the shot particle size, the person would have thought that large shot particles, such as of a size of 0.15 mm or 0.2 mm, are necessary for shot peening of the nitrided surface layer of the coil spring treated in the method of Izawa et al. The person would not have replaced the large shot particles with the fine shot particles (20 to 100 μm in diameter, see Abstract of Yamada) used by Yamada. Yamada could get by with fine shot particles in shot peening because the metal treated by the method of Yamada was carbon steel, which was not nitrided. **Non-nitrided** steel has been known to have a **much softer** surface than nitrided steel. Due to the significant difference in the hardness of the surface portion of nitrided steel, such as the steel used by Izawa et al, and non-nitrided carbon steel, such as the steel used by Yamada, the person would not have reasonably predicted that shot peening the nitrided steel coil springs of Izawa et al using the fine shot particles of Yamada would work. This is a reason why, in the mind of the person of ordinary skill in the art, the teachings of Yamada et al should not have been used to modify the method of Izawa et al.

JP '711 also fails to cure the first deficiency of Izawa et al because JP '711 teaches away from using fine metal particles in shot peening. The size of shot peening before surface hardening is 100 μm or more in JP '711, which does not teach the effectiveness of shot peening with fine metal particles having a diameter of less than 100 μm. In fact, JP '711 discloses the following in paragraph [0015]: "In the case shot particle diameter is less than 0.1 mm, kinetic energy of each shot particle is too small to effectively prevent formation of oxide film containing Si and/or Cr. For this reason, **the lower limit of the shot particle diameter must be 0.1 mm**. Further, the shot particle diameter is preferably 0.15mm and above, and more preferably 0.2mm and above" (emphasis added). Thus, JP '711 **teaches away** from shot peening using fine metal particles, wherein the mean diameter of each particle is in the range between 10 μm and 80 μm inclusive, used in the shot peening steps of the claimed methods.

The Office Actions from the U.S. PTO did not specifically explain why the U.S. PTO was not persuaded by applicants' teaching-away argument concerning JP '711. The U.S. PTO implied that it was not persuaded because JP '711 was merely cited to show that different orders of nitridation were known in the art and that shot peening could precede nitridation. However, even though JP '711 was cited by the Office Actions for a reason different from the size of metal particles used in shot peening, the person of ordinary skill in the art would have been cognizant of the fact that JP '711 teaches away from shot peening with the fine metal particles of the size used in the shot peening steps of the claimed methods. Because the person is presumed to have knowledge of all relevant prior art references, the person would have been influenced by the teachings of JP '711. As a result, the person would have no motivation to modify

the method of Izawa et al by replacing the large metal particles used in the second stage of the shot peening with the fine metal particles used in the claimed methods. Applicants request that the U.S. PTO specifically explain why it was not persuaded by applicants' teaching-away argument concerning JP '711.

Concerning the second difference (the failure of Izawa et al of teaching the use of an impact temperature below recrystallization temperature), the U.S. PTO argued that keeping the impact temperature below recrystallization temperature as taught by Yamada could help dislocation anchoring (see Abstract and col. 2, lines 62-67, of Yamada). Applicants respectfully submit that the person of ordinary skill in the art would not have any reasonable expectation that the teaching of Yamada on the improvement of dislocation anchoring by fine particle shot peening would succeed on the nitrided coil springs treated in the method of Izawa et al. The person would have known that keeping the temperature below recrystallization temperature can possibly anchor dislocations **if dislocations are generated** during shot-peening. Since the surface layer of nitrided springs treated by Izawa et al is very hard, the person of ordinary skill in the art would have thought that it would have been rather difficult to obtain plastic deformation in the surface layer of nitrided springs. So the person would have thought that elastic deformation, instead of plastic deformation, takes place predominantly. However, the person would also have known that elastic deformation does not generate dislocations. In such conditions, the person would have predicted no dislocation anchoring since dislocations are not produced. Since the person would have predicted that no dislocations would have been produced if the nitrided coil springs of Izawa et al were shot peened using the fine particles of Yamada, the person would

have no motivation to replace the large particles in the second shot peening step of the method of Izawa et al with the fine particles used by Yamada in order to keep the temperature below recrystallization temperature. JP '711 fails to cure the second deficiency of Izawa et al in view of Yamada because JP '711 does not teach controlling the instantaneous temperature rise due to collision by the fine metal particles low enough to cause work hardening in the spring surface layer but not to cause softening due to recovery/recrystallization.

The U.S. PTO took a position that applicants' argument in relation to the first and second deficiencies of Izawa et al was not persuasive because the arguments were against Izawa et al individually. Applicants respectfully disagree. Applicants' arguments were not directed to Izawa et al individually. Instead, applicants' arguments have been that the secondary references relied upon by the U.S. PTO did not cure the first and second deficiencies of Izawa et al. Thus, applicants' arguments were directed toward the entire body of prior art cited in the Office Actions.

Regarding the third difference between the instant claims and Izawa et al, i.e. the failure of Izawa et al in using the shot peening velocities recited in the instant claims, Yamada teaches a shot peening velocity of 80 m/sec (see Abstract). However, Yamada conducted the shot peening on a non-nitrided steel workpiece, which has a softer surface than the nitrided coil springs shot peened by Izawa et al. The person of ordinary skill in the art would not have used the shot peening velocity taught by Yamada in the method of Izawa et al because the person would have known that the nitrided coil spring of Izawa et al requires shot peening with a different kinetic energy than the non-nitrided steel workpiece of Yamada.

Applicants' arguments with respect to the obviousness rejection based on JP '216 as the primary reference were similar to the arguments against the obviousness rejection based on Izawa et al. as the primary reference. For instance, JP '216 does not disclose (a) the detailed shot peening conditions used in the claimed method and (b) controlling the instantaneous temperature rise due to collision so that there will not be softening due to recovery/recrystallization. Yamada and JP '711 should not have been combined with JP '216 because the workpieces shot peened in the methods of Yamada and JP '711 are made of non-nitrided steel. There would not have been a reasonable expectation by the person of ordinary skill in the art that the teachings of Yamada and JP '711 could successfully be applied to the steel workpiece of JP '216.

Because the secondary references cited by the U.S. PTO fail to cure the deficiencies of JP '216 or Izawa et al, applicants submit that the claims should not have been rejected as obvious. Withdrawal of the obviousness rejections based on either Izawa et al or JP '216 as the primary reference, and Yamada and JP '711 as secondary references, be withdrawn.

Conclusion

Consequently, for the reasons noted above, applicants respectfully submit that the application is in a condition for allowance.

In the event that this paper is deemed untimely, applicants petition for an appropriate extension of time. Any fee deficiency can be charged to Deposit Account No. 01-2300, referencing Docket No. 100725-00017.

Respectfully submitted,

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